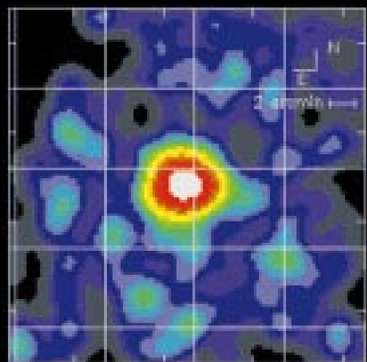

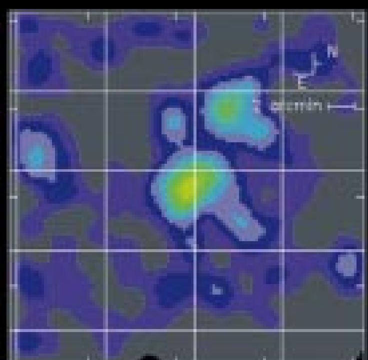

GLAST FACTS

Gamma rays are the highest energy form of electromagnetic radiation, or light. The gamma rays detectable by GLAST range from five million to 150 billion times more powerful than light visible to the human eye. Visible light is only a small portion of the total range of energy carried by light particles, called photons. This energy range, known as the electromagnetic spectrum, is shown with the familiar rainbow of colors visible to the eye. Higher energies are to the right, and lower energies are to the left.

Gamma radiation is so energetic that it presents a hazard to life. Fortunately, this high-energy radiation is blocked by the Earth's atmosphere. However, this requires that any gamma ray telescope be launched into space, above our atmospheric shield.

A gamma-ray telescope cannot be built like a visible light telescope, because gamma rays are too powerful to be focused by any lens or mirror. Detectors must be used instead. Gamma rays interact with material in the detector making tracks through it that can be used to give the location of an object emitting gamma rays. An instrument called a calorimeter then measures the energy of the incoming gamma ray.

GLAST, anticipated to launch in 2005, will be a considerable improvement over the successful Energetic Gamma Ray Experiment Telescope (EGRET) on board NASA's Compton Gamma Ray Observatory spacecraft. GLAST will be 30 times more sensitive than EGRET, and will be able to observe a range in photon energy that is 30 times larger. The field of view of GLAST is 5 times larger than EGRET's—about half the sky not blocked by Earth. GLAST's ability to localize sources on the sky is almost 10 times better in each dimension. GLAST is a cooperative effort involving a number of organizations in the United States and abroad.

GLAST is in the early stages of mission definition, known as Project formulation, at NASA's Goddard Space Flight Center (GSFC). For more information on GLAST, contact the GLAST Project Formulation Office at GSFC.

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GAMMA RAY LARGE AREA SPACE TELESCOPE

UNDERSTANDING THE MOST POWERFUL ENERGY SOURCES IN THE UNIVERSE

Our Universe is the stage for events of inconceivable power. Stars explode, outshining 100 billion suns. Matter is obliterated in the dark heart of a black hole or accelerated to almost the speed of light by explosions on the sun. Intense flashes of invisible light come from the edge of the cosmos.

Gamma-ray astronomy studies the most energetic objects and phenomena in the Universe. Gamma radiation, invisible to the human eye, is generated under the most extreme conditions. The mission of GLAST is to study these powerful objects and violent events in order to understand Nature at its ultimate limits. Exploring the limits often reveals new things and unanticipated phenomena, particularly in fundamental physics. This knowledge may eventually find application in current technologies or create technologies that are entirely new. GLAST is part of the Structure and Evolution of the Universe (SEU) theme in NASA's Office of Space Science. Through the SEU program scientists seek to explore the limits of gravity and energy in the universe, explain the structure of the universe, and forecast our cosmic destiny.

GLAST SCIENCE

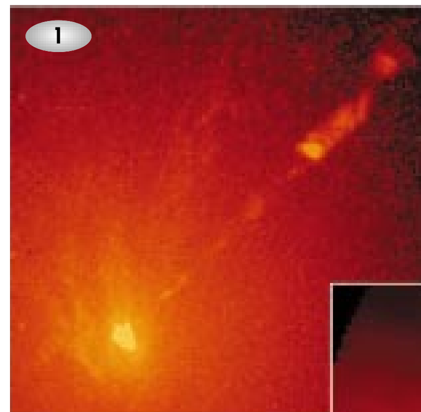
1. THE FIERY CENTER OF A GALAXY: Blazars

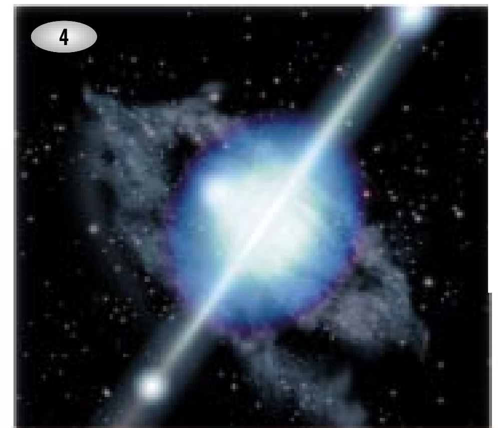
Galaxies are immense aggregations of billions of stars, held together by their mutual gravity. The center of some galaxies is occupied by an incredible power source, estimated to be only about the size of our solar system, that shines with the equivalent of trillions of suns. Called active galactic nuclei (AGN), these extremely bright objects often eject jets of matter in opposite directions at nearly the speed of light, and are called blazars in the cases where one of the jets is pointed directly at us. GLAST will study blazars to understand how the enigmatic jets form. GLAST will also probe the suspected source of the AGN's power—a monstrous black hole with a mass approximately one billion times greater than the sun.

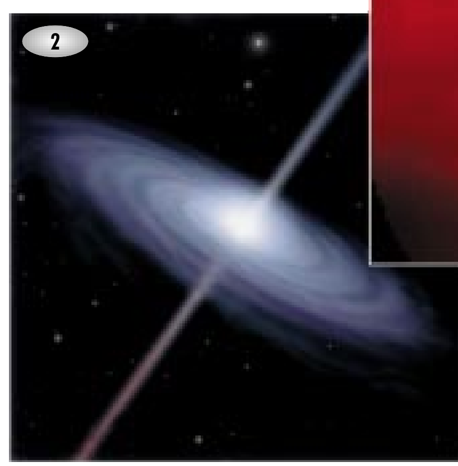
2. A VIRTUAL TOUR OF A BLACK HOLE

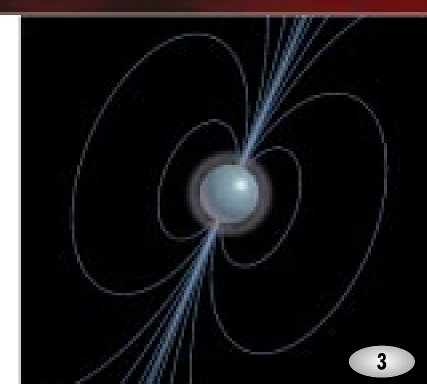
Like a stellar ghost, black holes are left behind when a massive star ends its life in a violent explosion called a supernova. The outer layers of the star are blown off while the core collapses under its own gravity to become a black hole. The core, with the mass of five or more suns, is crushed to an infinitesimal point, generating an intense gravitational field. Near a black hole nothing, not even light, can escape its gravitational embrace. A black hole is therefore invisible, a dense shadow of a star that can be detected only by its pull on nearby matter.

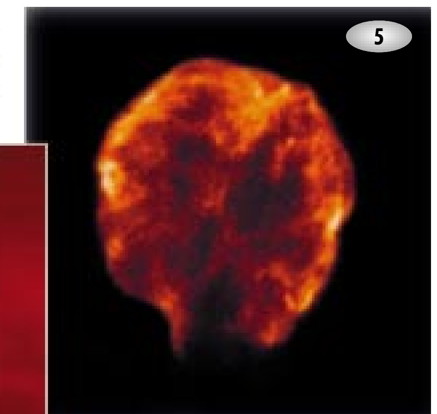
Many of the suspected black holes are orbiting a close companion star; or, in the case of supermassive black holes at the centers of galaxies, have swarms of stars orbiting them. The black hole's gravity pulls gas from a nearby star or gas cloud into a disk of material which swirls around the black hole before plunging in, much as soap suds swirl around a bathtub drain. As it falls into the black hole, gas in the disk is compressed and heated to millions of degrees, emitting radiation of various types.

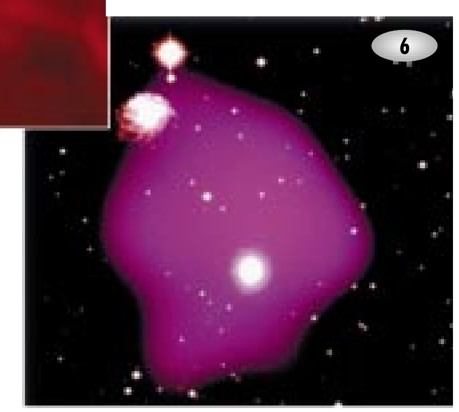












Though the black hole's attraction is relentless, not all matter near a black hole is doomed to fall inside. An apparent paradox, some black holes actually eject high velocity jets of matter in opposite directions. These jets form outside the black hole's point of no return, called the event horizon, and blast material to freedom at almost the speed of light.

Gamma rays are emitted from these high speed jets. GLAST will observe gamma radiation from jets ejected by supermassive black holes to determine what happens to matter in the vicinity of these awesome power plants and perhaps learn how some matter on the edge of oblivion escapes a seemingly inexorable fate.

3. HEARTBEAT FROM A DEAD STAR: Pulsars

If the collapsing core of an exploding star does not have enough mass to form a black hole, it will leave behind a dense, stellar cinder known as a neutron star. This city-sized star contains about as much material as our sun. It is so dense that subatomic particles called neutrons are the primary form of matter found inside the star, hence the name. If it were possible to bring some to Earth, a marble-sized piece of neutron star matter would weigh approximately 100 million tons. Neutron stars have intense magnetic fields, typically one trillion times greater than the Earth's magnetic field.

Some rotating neutron stars emit beams of high speed subatomic particles and electromagnetic radiation from the poles of their magnetic fields. This radiation can be detected on Earth as regular pulses as the beam sweeps by like a lighthouse beacon; these neutron stars are called pulsars.

GLAST will scrutinize gamma radiation from pulsars to determine how they accelerate particles to such high velocities. GLAST will also examine gamma radiation to determine what kinds of particles are found in their beams. The extreme density of a pulsar creates pressures unattainable in laboratories on Earth and may compress matter into novel forms. GLAST may also be able to analyze gamma radiation from pulsars to help reveal their internal structure and perhaps gain insight into the exotic types of matter formed by the tremendous pressure in their interior.

4. GAMMA RAY BURSTS: Cosmic Mystery

Gamma-ray bursts are the most powerful explosions known. They occur randomly throughout the sky as brief but intense flashes of gamma radiation. Recently, it has been determined that they are extremely distant, almost at the edge of the observable Universe. It is hard to comprehend how energetic they are; it is best done in steps. Our sun produces enough energy in one second to meet the United States demand for nine million years. Our sun is an average star, and our Galaxy is composed of approximately 100 billion stars. A typical 30 second gamma-ray burst releases an amount of energy equal to that produced by our entire galaxy during a one year period.

The cause of the blasts is unknown. Many theories have been advanced, and observations from GLAST will help determine if any are valid, or if the bursts are a completely new phenomenon.

5. COSMIC PARTICLE ACCELERATORS: Supernova Remnants and Solar Flares

The Earth is constantly being bombarded by a shower of high speed subatomic particles from space called cosmic rays. Traveling at nearly the speed of light, the highest energy cosmic rays carry millions of times more energy than the most powerful particle accelerators on Earth can produce.

There are several sources in the cosmos that appear to produce cosmic rays. Solar flares are explosions in the atmosphere of the sun. GLAST will observe these events to understand how they occur and how they accelerate a sleet of rapidly moving particles. Supernova explosions can generate cosmic rays with much greater energy. GLAST will observe the gaseous remains of supernovae to see how shocks within accelerate particles to such high velocities.

6. SEEING THE INVISIBLE: Dark Matter

Strange as it may seem, there is strong evidence that 90 percent of the mass in the Universe is invisible. This unknown form of matter, called dark matter, is only detectable by its gravitational effects on ordinary, visible matter. As in the case of the mysterious gamma-ray bursts, many theories have been proposed to explain what dark matter might be. One theory suggests that dark matter may be a type of hypothetical subatomic particle called a weakly interacting massive particle, or WIMP, a totally new form of matter. This theory predicts that WIMPs may interact with other WIMPs and annihilate each other, producing gamma rays at a specific energy level. If so, GLAST may detect this radiation, solving one of the most significant mysteries in astronomy.